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NOTES OF A LESSON ON ARITHMETIC,[*]

Given at the House of Education, Ambleside, by Miss DOROTHEA BEALE, *Principal of the Cheltenham Ladies' College.*

HAVE you ever thought how wonderful it is that in one minute we can multiply thousands and hundreds together? It is easy for us to multiply and divide large numbers, but it was not so with some of the cleverest nations of old times. The Greeks and Romans could not do the sums that children in infant schools can do now, because they had not thought of our ways. You know how long it takes to write the names of the Bible chapters in Roman character, *e.g.*, chapter 49 = chapter xlix., and the number 89 = lxxxix. The Romans need two or three times as many letters.

Let us try to think how people first began to calculate. Do you know what calculus is in Latin? It is a pebble. I think in old times when, for example, a shepherd was sent out with a large flock, the master would have at home perhaps a heap of pebbles, and the shepherd a bag with a number of small stones corresponding to the number of his sheep. Was that the beginning of shepherds having stones in a long bag, such as that with which David killed Goliath. Look at 1 Sam. xvii. 49.

Another way which we should think more convenient would be to cut notches in a stick, but, you must remember people had not convenient pocket-knives, which you have, in those early days. People used flint, and it is not so very easy to cut a notch in wood with a stone. But when men had got later to use metal I think they cut notches; and we read of old tally sticks, on these could be marked the number of sheep in a flock. But think what a long stick you would want, for say a hundred sheep, and for five hundred you would want five long sticks. Now we all have a ready-reckoner, I may say literally "at hand," with which we do small sums—they are our five fingers. The Latins called them digits, and when they had five notches to make they seem to have put a mark representing the hand, or V, by this means you could manage with one stick instead of five sticks for five hundred sheep. But, why should you not represent two hands together. This would stand for two hands or ten fingers X. Then you might have one stick for 1,000 sheep. The Latins had other marks, for instance L ☞ stood for fifty, a handful of tens; they put C for centum, a hundred, and a few other letters—they had D and M, but they never seem to have thought of carrying as we do.

Some peoples have had special marks for a score, *i.e.*, all the fingers and toes. The Greeks, too, used the letters of their alphabet for numbers in the same way as the Latins.

When people began to trade they wanted something more than tally sticks and stones, and something the value of which all knew. Amongst the pastoral peoples the most ready things to calculate exchanges by were their cattle or sheep. A piece of land would be sold for so many sheep. But it was difficult to drive sheep about, so very early people seem to have had pieces of metal, say silver pieces, with perhaps a sheep scratched on it, and this was called from *pecus* (cattle), *pecunia*, the piece of metal which represented the value of a sheep.[*] This could be carried about and exchanged. Lawyers now put in our wills, goods and chattels—by the first they mean houses and lands which cannot be moved; by the latter, things which can be moved.

The ancients could not possibly write in such a language as theirs, the large numbers we constantly use, without which much of astronomy would be impossible, nor could they write anything but the simplest fractions. Suppose you try to see how difficult and even impossible it was.

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[*] It is most difficult to write what can be made quite clear at the blackboard. From long experience I have found that quite young children can understand the working sums in different scales, doing what we call Goliath's arithmetic, and that it makes them understand the processes of ordinary arithmetic better than anything else. The sums given should be very simple ones. I think it a matter of primary importance to lead children along the track of discoverers. It was by reading the stories of travel and adventure, that men were led to explore the world, and by the same means they are inspired to explore the world of thought.

[*] We read of Abraham's weighing shekels of silver when he bought the burying ground.

Then the Romans had another very puzzling plan. They said it seemed so lengthy to write VIIII for nine, so they put one mark before the X, and when a lower number was put before a higher, it meant this number was to be taken away, the IX = VIIII, XL = XXXX.

Let us see how hard it was for the Latin boys to work sums.

Suppose they wanted to add 49 to 19, we do it in a minute and say 68. The Roman boy would write XLIX and XIX. There would be no good in putting one below the other. Then we would have, I suppose, to make two tables of "taking away letters" and "adding" ones, thus:—
Take away : X . I . I . Add : X . X . L . X. You see this would come to LXVIII.

I have heard of how some very clever doctors were spending the evening together in London, and they began talking about Roman arithmetic, and they tried to do sums, and were surprised to find how hard it was, and some of them would not go to bed until they had done a few sums, and it was getting towards morning before they finished. Here is quite an easy one which you might try—

Suppose a centurion had to pay fifty-nine men nineteen denarii each, how much would he have to get from the treasury?

LIX men, XIX denarii. Perhaps he would write down the XIX fifty-nine times, for multiplication is really addition, but shortened for those who know their tables. He might do it perhaps somewhat as we do multiplication, thus—

	TAKING AWAY.	ADDING.
LIX	C	D
XIX	X	C
	L	X
	X	I
	C	D
	X	C

He might begin X times X would be C—but a taking away C, because the first X is a taking away; X times a taking away I would be a taking away X, then X times L would be D; and so on.—Total, DCCCCXXXI.

I can't think how they would manage a division, except by writing down the numbers whole.

It seems that it was a very long time before people thought of another plan, not making a different shaped figure but putting the same mark in a different place and so altering its value. Have you seen a sign sometimes on public houses like this, and the house called "The Chequers." Well, it seems that people began by putting, say on the *counter*,—notice the word—lines; then, when a man had had his, say, ten glasses of beer, the stick or the stone, or the X which the man would put for his name, would be moved to the next row; and debts could easily be put down in this way. Now that, which seems such a simple thing, was really the foundation of the great advance in arithmetic, which makes it possible for us to do what people could not in ancient times. Here would be the original plan. A sort of gridiron would be drawn and numbers put down thus:—Here a number in the front row stands for a single thing; in the second for ten things; in the third for ten tens, and so on. Here we have 7 hundreds and 5. But, after a little, people said, "We don't want all these lines. If we could show where there was a row missed, it would do as well." So they settled that the last figure should stand for ones and every empty row should be marked by a 0—705. Here we want no bars. And, you see, all nations agreed that each row should be ten times as much as the row before, because we all had the same ready-reckoner in our five fingers. Now, as soon as this plan was thought of, it became easy to write down numbers of immense value in almost no time, numbers so large that we cannot think them. Here we have hundreds of thousands, which it would have taken Romans a long time to write, written in half a minute, and we could go on to millions and trillions of miles and give the distances of stars. Not only that, but we can write quantities ever so small, too, for if the value increases as we move to the left, and decreases as we go to the right, down to the unit row, why should it not go on decreasing beyond; then we get tenths and hundredths, and we may go down to millionths and beyond, and write the

X	X	X
X	X	X
X	X	X

1000	100	10	1
	7		5

10000	1000	100	10	1
1	2	3	4	5

size of the creatures that can be seen only in microscopes. Here is a table extending both sides of the unit row—we read it: 7 hundreds, 3 tens, 1 unit, 2 tenths, 4 hundreths. I wish people had made some mark over the unit row when they abolished the gridiron. It would have looked more even, but they always put a dot after to mark the unit, thus $73\overset{x}{1}24$, and this would be written 731·24.

100	10	1	$\frac{1}{10}$	$\frac{1}{100}$
7	3	1	2	4

Do you think Goliath would have used the ten scale? I think he would have made the numbers twelve times as much, used what we call the twelve scale, and it does seem as if there must have been some who used Goliath's arithmetic, for you know how we reckon by dozens. Here is some giants' or duodecimal arithmetic; you carry on tens first and then twelves, add 5s. 7d. to 4s. 9d. = 10s. 4d.

Notice that in subtracting, what we really do is to take one of the shillings we have, change it into pennies, and then subtract. Of course, we could do sums in any scale we like, but all our language is made for the ten scale, and we have learnt our tables in that. Twenty means twain tens, thirty, three tens. Still, let us try. Suppose we were to think of one hand only, and to carry fives instead of tens. This would give us the five scale. What would 4 3 2 be in the five scale? Make a set of bars, and translate into the ten scale. The first figure is worth 2; the second is 3 fives; the third 4 twenty-fives, 2 + 15 + 100 = 117.

25	5	1
4	3	2

Let us work an addition and subtraction sum in this scale, translate each line also into our common scale to prove it. Proof in the ten scale:—117 + 99 = 216, 117—99 = 18. To prove it we translate the answers into the ten scale: 1 + 15 + 75 + 125 = 216; 3 + 15 = 18.

(1)

125	25	5	1
	4	3	2
	3	4	4
1	3	3	1

(2)

25	5	1
4	3	2
3	4	4
	3	3

You notice we cannot write any number higher than four in the five scale, because 5 or 6 would carry to the next row.

Suppose we work in the twelve scale, we should have to make another figure to represent 10 and 11, as we could not carry them.

1728	144	12	1
	5	e	4
	t	7	e
1	4	7	3

Proof in the ten scale: 4 + 132 + 720 = 856, 11 + 84 + 1440 = 1535; 856 + 1535 = 2391. Translate the answer into the ten scale 1728 + 576 + 84 + 3 = 2391.*

In algebra books and in some arithmetic books you will find more examples that you might work, but I hope this will help you to understand better the sums you have been used to do. It is said we owe our system of arithmetic to the Arabs, and that they got some hints from later Greeks. The Arabs certainly studied algebra, the very name tells us that; and have you noticed that we write our sums as it were backwards—the opposite way to that in which we write words. Now, that is the way people do write oriental languages—Hebrew and Arabic.

You will find this and many other things made much clearer when you come to do algebra. Look in your chronological chart and see the period of the great Caliphs—then see what terrible hindrance to progress was caused by wars.

Many great and wonderful inventions have been made by men, sometimes owing to the need of defending themselves against enemies. Read the story of Archimedes. But they want also quiet to think out things, and so discovery has also been hindered; but, in later times, especially since the 17th century, the time of Newton, wonderful progress has been made—in that century logarithms were invented, by which we are able to turn multiplication into addition. You know how much shorter it is to add up numbers consisting of six or seven figures than it is to multiply, say, 2,398,764 by 9,843,261; but, better still, we can avoid doing a long division sum, and only subtract instead.

Then, strange to say, calculating machines have been invented; we turn a handle and find our sum worked for us. You must learn to understand these some day.

And I should like you to read about many discoverers in this kingdom of truth. You like to know about Livingstone and others who explored the dark continent. Well, there is a realm of darkness, which God has given to the children of men to conquer, and every advance into that wins territory not for ourselves alone, but for all the world—that kingdom is infinite, and in winning a bit of it, we take from nobody. It is Noman'sland now, but it becomes every one's land as soon as some conqueror like Newton takes possession. You might read Professor Lodge's book about the pioneers or discoverers, and I hope it will make you think—"I too will try whether I can't help to win a few fields in that kingdom of truth. I will try just to understand and see what these great men have done, and following in their footsteps, help to move forward a little further the army of light"—that army to which all who seek the truth belong; resolve that you will not be laggards, but brave and faithful workers—that you will not give up because you find things hard, but remember the words of one of the wisest of the Greeks, that all beautiful thoughts are hard to attain. No pains should be too great for us to take, if we can thereby understand more of the lessons which our Heavenly Father is teaching us.

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*Here Miss Beale worked on the blackboard a subtraction sum in the 7 scale; a long division in the 6 scale; a multiplication in the 4 scale; a short division in the 5 scale. As it is difficult to print these sums, we shall leave it to the intelligence of our readers.

BAD BRINGING UP.

By T. G. Rooper, M.A., H.M.I.

(*Continued from page* 167.)

If then management of children by little acts of deception is bad bringing up, what is good bringing up? I must draw a distinction between good bringing up and good breeding. A child may be at once well bred and yet badly brought up. A child is well bred or not, according as he behaves in the presence of company, and his breeding is good if his attitudes are easy and graceful, his language simple and correct and his manners thoughtful and gentle. Does he answer when spoken to, replying in the spirit in which he is addressed, playfully if so addressed, seriously if questioned with a purpose, does he show great reverence for old age, does he open the door, or fetch the stool or think of such small attentions to the guests which it may be in his power to show them, does he ask after playmates and show himself well instructed in social conventionalities. Then the child is well bred. All this, however, he may accomplish and yet when the constraints of society are absent he may be illtempered and selfish.

A child may be well bred and yet badly brought up, for good bringing up is the result of all the words that reach the child's ear, of all the thoughts which are suggested to his mind in hourly intercourse, of all the examples which are offered to his eye and all the acts of his daily life. Parents have an army of auxiliaries in training their children. There are servants, there are companions, there are friends and relations. It is unlikely that any child can be always surrounded by good influences and none other. Indeed this seems hardly desirable. It is not the object of the parent to keep his child in ignorance of evil, for ignorance is not really innocence. What is necessary is, that the child should